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Internal combustion engines — Piston rings —

Part 4: General specifications

Moteurs à combustion interne — Segments de piston —

Partie 4: Spécifications générales

Reference number
ISO 6621-4 : 1988 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 6621-4 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Internal combustion engines — Piston rings —

Part 4: General specifications

0 Introduction

ISO 6621 is one of a series of International Standards dealing with piston rings for reciprocating internal combustion engines:

ISO 6621, *Internal combustion engines — Piston rings —*

Part 1: Vocabulary.

Part 2: Measuring principles.

Part 3: Material specifications.

Part 4: General specifications.

Part 5: Quality requirements.

ISO 6622, *Internal combustion engines — Piston rings —*

Part 1: Rectangular rings.

Part 2: Rectangular rings with narrow ring width. [1)]

ISO 6623, *Internal combustion engines — Piston rings — Scraper rings.*

ISO 6624, *Internal combustion engines — Piston rings —*

Part 1: Keystone rings.

Part 2: Half keystone rings. [1)]

ISO 6625, *Internal combustion engines — Piston rings — Oil control rings.*

ISO 6626, *Internal combustion engines — Coil-spring-loaded oil control rings.*

1 Scope and field of application

This part of ISO 6621 lays down the general characteristics of piston rings, individual dimensional criteria of which are specified as appropriate in the International Standards and Technical Reports cited in clause 0.

This part of ISO 6621 also provides a system for coding, designation and marking of the piston rings.

The requirements of this International Standard apply to all rings up to and including 200 mm diameter covered by the above classification for both reciprocating internal combustion engines and compressors.

2 Reference

ISO 6507-3, *Metallic materials — Hardness test — Vickers test — Part 3: Less than* HV 0,2. [2)]

3 Terminology

The terminology used in this part of ISO 6621 is as given in ISO 6621-1.

4 Piston ring codes

Codes used for piston rings shall be as given in table 1 with their explanatory descriptions.

1) Part published as a Technical Report (ISO/TR 6622-2 and ISO/TR 6624-2).

2) At present at the stage of draft.

Table 1 — Codes and descriptions

Code	Description	Relevant International Standard or Technical Report
R	Straight-faced rectangular ring	ISO 6622-1, ISO/TR 6622-2
B	Barrel-faced rectangular ring	ISO 6622-1, ISO/TR 6622-2
M1 to M5	Taper-faced rectangular ring	ISO 6622-1, ISO/TR 6622-2
N	Napier ring (undercut step)	ISO 6623
NM1 to NM4	Napier ring (undercut step), taper-faced	ISO 6623
E	Scraper ring (stepped)	ISO 6623
EM1 to EM4	Scraper ring (stepped), taper-faced	ISO 6623
T	Straight-faced keystone ring 6°	ISO 6624-1
TB	Barrel-faced keystone ring 6°	ISO 6624-1
TM1 to TM5	Taper-faced keystone ring 6°	ISO 6624-1
K	Straight-faced keystone ring 15°	ISO 6624-1
KB	Barrel-faced keystone ring 15°	ISO 6624-1
KM1 to KM5	Taper-faced keystone ring 15°	ISO 6624-1
HK	Straight-faced half keystone ring 7°	ISO/TR 6624-2
HKB	Barrel-faced half keystone ring 7°	ISO/TR 6624-2
S	Slotted oil control ring	ISO 6625
G	Double-bevelled oil control ring	ISO 6625
D	Bevelled-edge oil control ring	ISO 6625
DV	Bevelled-edge V-groove oil control ring	ISO 6625
DSF-C	Coil-spring-loaded bevelled-edge oil control ring, chromium-plated and profile ground	ISO 6626
DSF-CNP	Coil-spring-loaded bevelled-edge oil control ring, chromium-plated, not profile ground	ISO 6626
SSF	Coil-spring-loaded slotted oil control ring	ISO 6626
GSF	Coil-spring-loaded double-bevelled oil control ring	ISO 6626
DSF	Coil-spring-loaded bevelled-edge oil control ring	ISO 6626
DSF-NG	Coil-spring-loaded bevelled-edge oil control ring (face geometry similar type DSF-C or DSF-CNP)	ISO 6626
SSF-L	Coil-spring-loaded slotted oil control ring with 0,6 mm nominal land width	ISO 6626
D22	Radial wall thickness $a_1 = d_1/22$	ISO 6622-1, ISO 6623
MC11 to MC63	Material subclasses	ISO 6621-3
MR	Ratio m/d_1 reduced	ISO 6621-4, 7.4
Z	Ring shape round	ISO 6621-4, 7.1
Y	Ring shape negative ovality	
S00 to S10	Closed gap (minimum values)	ISO 6621-4, 7.3
CRF to CR4	Periphery chromium-coated fully faced design	ISO 6621-4, 9.3
CR1E to CR4E	Periphery chromium-coated semi-inlaid design	
CR1F to CR4F	Periphery chromium-coated inlaid design	
MO1 to MO4	Periphery molybdenum-coated fully faced design	ISO 6621-4, 9.3
MO1E to MO4E	Periphery molybdenum-coated semi-inlaid design	
MO1F to MO4F	Periphery molybdenum-coated inlaid design	
LF	Uncoated ring periphery or uncoated land periphery, fully lapped	ISO 6621-4, 7.2
LP	Taper-faced piston ring with lapped land over the whole circumference but not over the whole width of the periphery	ISO 6621-4, 7.2

Table 1 — Codes and descriptions (*concluded*)

Code	Description	Relevant International Standard or Technical Report
FE	Ferro-oxided on all sides	ISO 6621-4, 10.1
PO	Phosphated on all sides	ISO 6621-4, 10.2 and 10.3
PR	Phosphated on all sides (for rust protection purposes)	
KA	Peripheral edges chamfered	ISO 6622
KI	Inside edges chamfered	
IF	Internal bevel (top side)	ISO 6622
IFU	Internal bevel (bottom side)	
IW	Internal step (top side)	
IWU	Internal step (bottom side)	
IFV	Variable internal bevel (top side)	
IFVU	Variable internal bevel (bottom side)	
NE1 to NE3	Ring joint with lateral stop	ISO 6621-4, 8.1
NH1 to NH3	Ring joint with internal stop	
WK	Reduced slot length	ISO 6626
WF	Reduced heat set	ISO 6621-5, ISO 6626
CSN, CSG, CSE	Type of coil spring	ISO 6626
PNE, PNL, PNR, PNM, PNH, PNV	Contact pressure class	ISO 6626
	Additional marking:	ISO 6621-4, 6.2
MM	manufacturer's mark	
MZ	mark for required ring shape "round"	
MY	mark for required ring shape "negative ovality"	
MX	material mark [1]	
MU	any other additional mark [2]	

1) Material mark (for alternative materials) at the discretion of the manufacturer.

2) Any other additional marking on purchaser's request shall be quoted clearly in the order; it shall be agreed between manufacturer and purchaser.

5 Designation of piston rings

5.1 Designation elements and order

To designate piston rings complying with the relevant International Standards and Technical Reports, the following details shall be given, in the order shown below.

The codes given in table 1 shall be used.

5.1.1 Mandatory elements

The following mandatory elements shall constitute the designation of a piston ring:

— designation, i.e. piston ring;

— number of International Standard or Technical Report;

— type of piston ring, e.g. R;

— hyphen;

— size of piston ring, $d_1 \times h_1$;

— code D22 if the selected wall thickness in accordance with ISO 6622-1 and ISO 6623 is D/22;

— hyphen;

— material code, e.g. MC11.

5.1.2 Additional elements

The following optional elements may be added to the designation of a piston ring; in this case, they shall be added on a second line beneath the mandatory elements, or separated by a solidus (/):

— code for reduced ratio m/d_1, MR;

— code for ring shape, e.g. MZ;

— code for the selected nominal closed gap if it differs from the closed gap specified in the dimensional tables, e.g. S05;

— code for the selected coating, e.g. CR3;

— code for uncoated rings with fully lapped periphery or taper-faced rings with partial lapped periphery, e.g. LF or LP;

— code for the selected surface treatment, e.g. PO;

— code for the selected peripheral edge feature, e.g. KA;

— code for the selected inside edge feature, e.g. KI;

— code for the inside step or bevel, e.g. IWU;

— code for the selected notch to prevent ring rotation, e.g. NH1;

— code if reduced slot length is required, WK;

— code if the coil spring with reduced heat set is required, e.g. WF;

— code for the selected type of coil spring, e.g. CSG;

— code for the selected pressure class, e.g. PNM.

5.1.3 Elements for additional marking

Any additional marking shall follow the additional elements specified in 5.1.2:

— code if manufacturer's mark is required, MM;

— code for marking of required ring shape, e.g. MZ;

— code for material, MX [see table 1, footnote 1)];

— code for any other marking, MU [see table 1, footnote 2)].

5.2 Designation examples

5.2.1 Designation of a piston ring complying with the requirements of ISO 6622-1,

— a straight-faced rectangular ring (R);

— of nominal diameter d_1 = 90 mm (90);

— and a nominal ring width h_1 = 2,5 mm (2,5);

— made of grey cast iron, non-heat-treated, material subclass 11 (MC11):

Piston ring ISO 6622-1 R - 90 × 2,5 - MC11

5.2.2 Designation of a piston ring complying with the requirements of ISO 6624-1,

— a keystone ring 6°, taper-faced (TM1);

— of nominal diameter d_1 = 105 mm (105);

— and nominal ring width h_1 = 2,5 mm (2,5);

— made of spheroidal graphite cast iron, martensitic type, material subclass 51 (MC51);

— ring shape round (MZ);

— with selected closed gap of 0,3 mm (S03);

— inside edges chamfered (KI);

— periphery chromium-plated, with layer thickness 0,1 mm min. (CR2):

Piston ring ISO 6624-1 TM1 - 105 × 2,5 - MC51 Z S03 KI CR2

5.2.3 Designation of a piston ring complying with the requirements of ISO 6626,

— a coil-spring-loaded, bevelled-edge oil control ring, chromium-plated and profile ground (DSF-C);

— of nominal diameter d_1 = 125 mm (125);

— and nominal ring width h_1 = 5 mm (5);

— made of grey cast iron, non-heat-treated, material subclass 11 (MC11);

— a selected closed gap of 0,2 mm (S02);

— a chromium layer thickness on the lands of 0,15 mm min. (CR3);

— phosphated on all cast iron surfaces to a depth of 0,002 mm min. (PO);

— reduced slot length (WK);

— coil spring with reduced heat set (WF);

— and variable pitch with coil diameter, d_7 ground (CSE);

— tangential force F_t according to the medium nominal contact pressure class (PNM);

— and the ring marked with manufacturer's mark (MM):

Piston ring ISO 6626 DSF-C-125 × 5 - MC11 S02 CR3 PO WK WF CSE PNM MM

6 Marking of piston rings

The requirements and recommendations for piston ring marking in 6.1 and 6.2 apply to piston rings of 1,6 mm radial wall thickness and above. Marking of piston rings below 1,6 mm is at the choice of the manufacturer.

6.1 Mandatory top side marking

All rings requiring orientation shall be marked to indicate the top side only, i.e. the side nearest to the combustion chamber.

In the absence of any other mark agreed between manufacturer and purchaser, the mark TOP should be used.

Marking of the top side applies to the following types of ring:

— all taper-faced rings;

— all internally bevelled or stepped rings;

— all semi-inlaid rings;

— all scraper rings;

— all half keystone rings;

— all directional oil control rings.

All such rings requiring marking are shown in the "common features" clause of the appropriate International Standards: ISO 6622, ISO 6623, ISO 6624, ISO 6625 and ISO 6626.

6.2 Additional marking

Additional marking of piston rings is optional or at the purchaser's request.

Such additional marking comprises the following:

— manufacturer's mark;

— mark for required ring shape;

— material mark (for alternative materials);

— any other additional mark agreed between manufacturer and purchaser.

7 General characteristics

7.1 Ring shape

Degrees of ovality only apply to rectangular rings (ISO 6622), scraper rings (ISO 6623) and keystone rings (ISO 6624). The forms of ovality are

— positive ovality, i.e. standard without a code;

— round, code MZ;

— negative ovality, code MY.

Values are given in table 2.

7.2 Light-tightness

At least 90 % of the piston ring periphery shall be light-tight.

Taper-faced rings with coated and ground periphery without lapped land shall be at least 95 % light-tight.

The following piston ring designs shall be 100 % light-tight:

— uncoated piston rings with periphery fully lapped;

— taper-faced piston rings uncoated or coated with lapped land over the whole circumference but not over the whole width of the periphery;

— piston rings with periphery chromium-plated or molybdenum-coated (fully faced, semi-inlaid or inlaid design) with lapped land over the whole width of periphery.

NOTE — In the case of piston rings with treated surface, the light-tightness is normally measured prior to surface treatment. When it is checked after treatment, rotation of the ring in the gauge will be required.

In the case of rings with negative point deflection, visible light is permitted at the butt ends but should be confined to the angle θ defined in ISO 6621-2.

Table 2 — Ovality

Dimensions in millimetres

Nominal diameter d_1	Positive ovality	Round [1]	Negative ovality [2]
$30 \leqslant d_1 < 60$	0 to + 0,60	− 0,30 to + 0,30	− 0,60 to 0
$60 \leqslant d_1 < 100$	+ 0,05 to + 0,85	− 0,35 to + 0,35	− 0,70 to 0
$100 \leqslant d_1 < 150$	+ 0,10 to + 1,10	− 0,45 to + 0,45	− 0,95 to − 0,05
$150 \leqslant d_1 \leqslant 200$	+ 0,15 to + 1,35	− 0,50 to + 0,50	− 1,10 to − 0,10

1) For taper-faced coated and uncoated rings with lapped land, the recommended ring shape is round.

2) Not applicable for material class 10 of ISO 6621-3.

7.3 Closed gap

Whenever the selected closed gap differs from that given in the dimensional tables of the specific International Standards, the codes in table 3 apply and the tolerances remain the same.

Table 3 — Closed gap

Dimensions in millimetres

Code	Closed gap
S00	0,05
S01	0,1
S02	0,2
S03	0,3
S04	0,4
S05	0,5
S06	0,6
S07	0,7
S08	0,8
S09	0,9
S10	1,0

7.4 Tangential force, F_t, and diametral force, F_d, of single-piece piston rings

The individual types of piston rings are given in ISO 6622, ISO 6623, ISO 6624 and ISO 6625. The definitions of F_t and F_d are given in ISO 6621-2.

7.4.1 Calculation of F_t and F_d values in dimension tables of dimensional standards

The tangential and diametral forces of piston rings are tabulated in the dimension tables of the dimensional standards.

The values are calculated for

— the basic feature of each piston ring type;

— nominal radial wall thickness, a_1, and mean ring width, h_1 or h_3;

— piston ring material with a modulus of elasticity of 100 GN/m²*;

— a ratio of total free gap to nominal diameter (m/d_1) according to table 4.

NOTE — The calculation of the tangential forces and diametral forces of

— rectangular rings with narrow ring width made of steel (see ISO/TR 6622-2);

— half keystone rings made of steel (see ISO/TR 6624-2);

is based on a theoretical contact pressure of approximately 0,19 N/mm².

The ratio m/d_1 is quite different to the values given in table 4 and depends on the nominal diameter and the special radial wall thickness. This radial wall thickness is not in a constant ratio to nominal diameter because there are steps of wall thickness which belong to a range of nominal diameters (e.g. a_1 = 2,1 mm for d_1 = 52 to 57 mm).

7.4.2 Correction of F_t and F_d values

The F_t and F_d values shall be corrected when

— additional features such as rings with

coated periphery and/or
inside chamfered edges and/or
outside chamfered edges and/or
taper and/or
internal step or
internal bevel;

— piston ring materials with a modulus of elasticity other than 100 GN/m²*;

— a ratio of total free gap to nominal diameter (m/d_1) other than that given in table 4;

are being used.

The formulae for the regular ratio of total free gap to nominal diameter (m/d_1 regular) are given in table 4.

Table 4 — Regular ratio of total free gap to nominal diameter

d_1 mm	m/d_1
$30 \leqslant d_1 < 100$	$15\,\frac{1}{100}$
$100 \leqslant d_1 \leqslant 200$	$\left(17 - \frac{2d_1}{100}\right)\frac{1}{100}$

7.4.2.1 Multiplier factors for common features

For common features, the necessary multiplier correction factors are tabulated in the dimensional standards ISO 6622, ISO 6623, ISO 6624, ISO 6625, ISO/TR 6622-2 and ISO/TR 6624-2 under clause 5 "Force factors".

7.4.2.2 Multiplier force correction factors for materials

For materials specified in ISO 6621-3, the force correction factors given in table 5 are recommended.

* 100 GN/m² = 100 000 MPa = 100 000 N/mm²

Table 5 — Material-force correction factors

Material class	Material-force correction factor
10	0,9 to 1 [1)]
20	1,1 to 1,3 [1)]
30	1,45
40	1,6
50	1,6
60	2,0

1) Force correction factors for materials depend on the modulus of elasticity in the manufacturer's material specification:

$$\text{Correction factor} = \frac{\text{Typical modulus of elasticity in GN/m}^2}{100\ \text{GN/m}^2}$$

7.4.2.3 Multiplier force correction factors for ratio m/d_1

Piston rings made of materials in classes 30 to 60 increase the tangential force and diametral force in relationship to the modulus of elasticity (see table 5) when ratio m/d_1 regular is used.

For limitation of such increased forces, it is common to use reduced values of m/d_1. In table 6 the recommended correction factors for m/d_1 regular and m/d_1 reduced are given.

Table 6 — Force correction factors for ratio m/d_1

Material class	Factor for m/d_1 regular	Factor for m/d_1 reduced [1)]
10	1	—
20	1	—
30	1	0,825
40	1	0,75
50	1	0,75
60	—	0,75

1) Ratio m/d_1 reduced is given the code MR.

For calculation of real values of ratio m/d_1 reduced, the factors given in table 6 apply. Therefore the values of m/d_1 calculated with formulae given in table 4 have to be corrected with the correction factors in table 6.

7.4.3 Examples for correction of F_t and F_d

7.4.3.1 Designation of piston ring:

ISO 6622-1 B - 95 × 2,5 - MC53
MR CR2 IW

7.4.3.1.1 Multiplying factors:

1,6 for material subclass 53

0,75 for ratio m/d_1 reduced

0,85 for periphery chromium-plated CR2

0,78 for internal step

7.4.3.1.2 Calculation

Total force correction factor:

$$1{,}6 \times 0{,}75 \times 0{,}85 \times 0{,}78 = 0{,}796$$

Basic values F_t and F_d according to ISO 6622-1:

$$F_t = 18{,}5\ \text{N and } F_d = 39{,}8\ \text{N}$$

Corrected values:

$$F_t = 0{,}796 \times 18{,}5\ \text{N} \pm 20\ \%$$
$$F_t = 14{,}7\ \text{N} \pm 20\ \%$$
$$F_t = 11{,}8 \text{ to } 17{,}6\ \text{N}$$

and

$$F_d = 0{,}796 \times 39{,}8\ \text{N} \pm 20\ \%$$
$$F_d = 31{,}7\ \text{N} \pm 20\ \%$$
$$F_d = 25{,}6 \text{ to } 38\ \text{N}$$

7.4.3.2 Designation of piston ring:

ISO 6623 N - 70 × 2 D22 - MC24/MO2

7.4.3.2.1 Multiplying factors:

1,15 for material subclass 24

0,86 for periphery molybdenum-coated MO2F (inlaid type)

7.4.3.2.2 Calculation

Total force correction factor:

$$1{,}15 \times 0{,}86 = 0{,}989$$

Basic values F_t and F_d according to ISO 6624-1:

$$F_t = 9{,}2\ \text{N and } F_d = 19{,}8\ \text{N}$$

Corrected values:

$$F_t = 0{,}989 \times 9{,}2\ \text{N} \pm 30\ \%$$
$$F_t = 9{,}1\ \text{N} \pm 30\ \%$$
$$F_t = 6{,}4 \text{ to } 11{,}8\ \text{N}$$

and

$$F_d = 0{,}989 \times 19{,}8\ \text{N} \pm 30\ \%$$
$$F_d = 19{,}6\ \text{N} \pm 30\ \%$$
$$F_d = 13{,}7 \text{ to } 25{,}5\ \text{N}$$

7.4.3.3 Designation of piston ring:

ISO 6624-1 KB - 140 × 4 - MC42/MO4 KI

7.4.3.3.1 Multiplying factors:

1,6 for material subclass 42

0,83 for periphery molybdenum-coated MO4 (fully faced type)

0,96 for inside chamfered edges KI